We now turn to lymphocytes, and we're starting out with a generic picture of what many of them look like. This is a scanning electron micrograph of what could be any one of several different types of lymphocytes. One element they have in common is a very active plasma membrane, shown here with lots of extensions. Lymphocytes are defined as the cells in the lymph, and 99% of the cells in the lymph are of one of four general types, B cells, T cells, NK cells, and dendritic cells. They may comprise 99% of the cells in the lymph, but they also are active in the general circulation as well, where they make up maybe 20% to 40% of the cells found there. You may recall that the lymphoid lineage of the common lymphoid progenitor produces a variety of different cells, including B cells and T cells. Both of these are adaptive and rearrange their genes. The NK cells and dendritic cells are innate and do not rearrange genes. And we will spend a lot of time on the function of these cells in later lectures. But for now, I'm just trying to introduce the basics and give you a of overview of the cell type. Let's start with the B cells, which develop in the bone marrow. Now, here is our cartoon representation of a B cell. And I think B cells are about the most sophisticated cells in the whole immune system. So here, we have a James Bond B cell wearing a tuxedo. This cell has many clever strategies and options that it uses to protect you from the pathogens that threaten you. And at this stage, our B cell has membrane bound antibodies on the surface that serve like antennas to alert the cell to threats. They also have not shown here class two mhc molecules, and they use these to communicate specific threats to the th cells. That is, our bond will sense a pathogen and then will come back and let our version of the British Secret Service know exactly what the specific danger is looming to your body. At that point, the B cell gets the license to kill. The B cell divides and develops and matures into a plasma cell. Now, it can secrete antibodies, which are shown here in red. Antibodies are proteins, and plasma cells must crank out bunches of them. It gets bigger. It makes a lot of rough endoplasmic reticulum so that it can make all those antibodies. These cells live short and active lives, living about two weeks in the antibody production phase. And assuming you get well, some of the b cells will develop into memory cells. These are smaller and still have the antibodies embedded in the surface, but they'll sit around for years and even decades and wait for this antibody to be needed again in the future when a similar pathogen shows up. So, in the B lineage, we have small circulating lymphocytes, the enlarged plasma cells secreting antibodies, and memory cells held in reserve. The t cells will develop in the thymus, and again, they start out looking pretty anonymous. As part of their development, however, they have to decide whether to become a T cell or a th cell. Here we have the TC and the Th cells, and both of these have rearranged their T cell receptor. But, the TC cell has selected a CD8 co-receptor, and the Th cell has selected a CD4 co-receptor. Activated TC cells will turn into cytotoxic T cells and kill viral infected cells by attaching to MHC 1 with the CD8. The cells with the cd four, however, have a number of different options. Cells with a T cell receptor and a CD4 co-receptor are in charge of coordinating the immune response. They do not kill directly. They tell other cells when and what to kill and when to sand down. They will receive the information from presenting cells showing peptides on mhc two and make the decision as to which of these responses is best for the job. A lot of the details in this are things that we're going to come back to and look at later, but remember, we're going to make some important distinctions between CD8+ cells and

CD4+ cells, that is, TC and Th. And that means the Th cells will
come in a spectrum of different adaptations to tailor the response
discussed in lecture one. The last cell we're going to look
at is the natural killer, or NK cell, and
electron micrographs of the NK shell. So fairly big cells with
pretty ordinary round nuclei, a lot of granules, and you can see here,
a very active plasma membrane. So I thought the best way of
representing it would be a lot more fun. I consider the NK cells to be the seals,
or the green berets of your
immune attack system. That is, they're highly trained,
they come out ready to defend you, they don't require T cell instruction,
and they are armed and dangerous. This one has a ligand, and that will tell an infected cell
to die if it gets stuck with it. As a backup to that,
if an NK cell contacts a viral infected or cancerous cell, it has a lot of
ammunition in the form of granzymes and perforins that again, will help break
up the cell and send it into apoptosis. It has an MHC receptor,
which you can see here. This down regulates the attack by
the cell, so we colored it red for stop. That may seem strange to you, but this helps with the coordination
with the TC cells. On the other side, we have an upregulating
green Fc receptor that recognizes the stems of Y-shaped antibodies
that may be attached to a sick cell. That prompts an attack, and again,
the NK cell will attack that sick cell. The most interesting part of the cell
is the way the MHC receptor works. In a TC cell, the receptor will
recognize foreign antigen on MHC 1 and attack the cell. Well, a virus is not
your friend, and some viruses manage to down regulate
the production of MHC one so that they can hide in the cell and
not give out signals that the cell is really gone over to the dark side and
is producing virus. But then there's the NK cells. These guys are looking out
for you, and if they find a cell without MHC stuck out,
they will attack it. This is a general response,
and it's an innate response. It's a pattern. If you're not making MHC one,
there's something wrong with you, and it's off to apoptosis. You go. This
doesn't really have anything to do
exactly with what's on the MHC 1 molecule, but what the cell is doing is
checking
to make sure the cell is not hiding its MHC 1s in an attempt to keep
a dark secret at its interior. What about those lymphoid dendritic cells? Now,
we're really not
covering them at this point. There are many variations of dendritic
cells, and some of them come from myeloid, and some of them come
from lymphoid lineages, but both those types of cells
are capable of active Th cells. Exactly what the difference is is
an active subject of current research, and I'm always hoping for more news.